

Impact of Social Determinants on Vector-Borne Parasitic Diseases in Chad: A Case Study of Grand-Sido and Kouh-Est

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Abstract

Background: Social determinants of health (SDOH) significantly influence diseases with environmental components, like vector-borne parasitic diseases. This study aims to examine how these factors influence vector-borne parasitic diseases (VBPDs) transmission in Chad and provide recommendations for policy improvements. **Methods:** The study adopts the WHO Conceptual Framework of SDOH to compare two regions in Southern Chad: Kouh-Est, which has an ongoing vector control program, and Grand-Sido, which lacks such a program. The study includes both nomadic and sedentary populations to provide a comprehensive understanding of the SDOH influencing VBPDs. Households were randomly selected. Data on sociodemographic characteristics, literacy, knowledge of VBPDs and protective measures, and access to education and health facilities were collected. **Results:** A total of 202 households from 17 villages, including 820 participants, were surveyed. Agriculture, livestock, and fishing were the main occupations, involving 84.1% of participants. Literacy was low, with 36.7% non-educated, 47.7% completing primary school, 14.5% secondary school, and only 0.3% reaching tertiary education. Most villages lacked schools beyond the primary level, and nomadic populations were significantly less educated than sedentary ones ($p < 0.0001$). Over 65% of participants recognized malaria vectors, but trypanosomiasis awareness was higher in Kouh-Est (69.4%) than in Grand-Sido (52.9%) ($p < 0.001$). Less than 1% recognized river blindness vectors. Around 60% used mosquito nets, while 12.8% in Kouh-Est and 25.2% in Grand-Sido used alternative protection methods. A higher percentage of participants in Kouh-Est

(19.4%) and in Grand-Sido (10.1%) used no protection ($p < 0.001$). **Conclusion:** Educational deficiencies, lack of protective measures against vectors, inadequate healthcare resources, and lifestyle conditions aggravated by poor road infrastructure, limited transportation, and economic constraints contribute to worsened VBPDs outcomes in these rural populations. Addressing these systemic issues in the surveyed communities is essential for improving health equity and VBPDs outcomes in these regions specifically and in similar populations settings more broadly.

Keywords

Social Determinants of Health, Vector-Borne Parasitic Diseases, Chad

1. Introduction

Vector-borne parasitic diseases (VBPDs) are a major public health concern worldwide, disproportionately affecting low- and middle-income countries, where socio-economic and environmental conditions often facilitate their transmission. These diseases are transmitted by vectors, such as mosquitoes, flies, ticks and snails, which serve as carriers for parasites that cause debilitating and, in some cases, fatal illnesses. In sub-Saharan Africa, VBPDs remain a leading cause of morbidity and mortality, particularly in rural and impoverished regions. Among the most recurrent VBPDs, malaria [1], dengue [2], trypanosomiasis [3], schistosomiasis [4], and onchocerciasis [5] affect overall, over 700 million people annually, resulting in approximately 70,000 deaths each year. These diseases are classified among neglected tropical diseases, with the exception of malaria.

Trypanosomiasis, commonly known as African sleeping sickness, is caused by *Trypanosoma brucei gambiense* or *T. b. rhodesiense* and is transmitted by tsetse fly (*Glossina spp.*). The disease affects thousands of people annually across 37 countries, primarily in rural African communities, and, if left untreated, can lead to severe neurological damage and death [6]. Malaria, one of the deadliest VBPDs, is caused by *Plasmodium* parasites and transmitted by *Anopheles* mosquitoes. Over 200 million cases are reported globally each year, with the highest burden occurring among children under five in sub-Saharan Africa [1]. Schistosomiasis, a parasitic infection transmitted through freshwater snails, disproportionately affects populations in regions lacking adequate water, sanitation, and hygiene (WASH) infrastructure. This disease can result in chronic health issues and significant economic losses [7]. Finally, onchocerciasis, or river blindness, is caused by *Onchocerca volvulus* and transmitted by blackflies (*Simulium spp.*). It is the second most common infectious cause of blindness, with the highest prevalence in riverine areas of West and Central Africa [5].

Social determinants of health (SDOH) are the conditions in which individuals are born, grow, live, work, and age, all of which exert a significant influence on health outcomes. These determinants are particularly impactful for diseases with

strong environmental components, such as VBPDs. SDOH—such as poverty, lack of access to healthcare, inadequate housing, environmental degradation, and poor infrastructure are central to determining who is most vulnerable to these diseases. Solar and Irwin [8] highlight that such factors shape health inequalities, and this is especially true in regions heavily affected by vector-borne diseases, where the environmental and socio-economic conditions contribute to disease persistence. In addition to these broader determinants, migration, low literacy levels and a limited understanding of both the transmission mechanisms and prevention of VBPDs exacerbate the situation. The literature emphasizes that education plays a crucial role in health literacy, which affects people's capacity to make informed decisions about prevention measures [8] [9]. In many endemic areas, people lack adequate knowledge of preventive actions such as the use of insecticide-treated nets for malaria or avoiding water sources infested with schistosome-infected snails. These gaps in knowledge fuel the ongoing transmission of diseases. For example, in rural communities, access to clean water and proper sanitation is often lacking, leading to increased exposure to waterborne diseases. Colley *et al.* [7] explain that inadequate water, sanitation, and hygiene infrastructure perpetuates the cycle of infection, leading to chronic illness and socio-economic burdens on affected populations. Additionally, limited healthcare infrastructure and poorly resourced disease surveillance systems hinder early detection and timely treatment, further exacerbating disease outbreaks and mortality.

Poor housing and waste management practices also create ideal breeding grounds for disease vectors such as mosquitoes. These conditions, which are prevalent in many low-income areas, significantly increase the transmission rates of diseases like malaria. The result is a continuous cycle of infection that disproportionately affects marginalized populations who already face barriers to accessing healthcare and preventive measures.

Chad, a landlocked country in Central Africa, exemplifies the intricate relationship between SDOH and VBPDs. The country faces numerous socio-economic and environmental challenges, including widespread poverty, limited access to healthcare, and poor sanitation infrastructure [10]. These factors, coupled with a tropical climate conducive to the proliferation of disease vectors [1] [7] [11], have led to high incidences of vector-borne diseases like malaria, schistosomiasis, trypanosomiasis, and onchocerciasis [10] [12]-[14]. Additionally, the Chadian health system, despite the efforts of policy-makers, faces significant challenges in managing epidemics and providing adequate treatment due to limited resources. This is especially evident in rural areas, where vector control programs are scarce, and livelihoods predominantly depend on livestock farming, agriculture, and fishing.

This study aims to investigate the role of SDOH in shaping the transmission and impact of VBPDs in Chad. By analysing the intersection of socio-economic factors and public health data, the study seeks to provide a comprehensive understanding of how poverty, healthcare access, environmental conditions, and other

SDOH contribute to the spread of VBPDs. It provides recommendations for policymakers and health practitioners, emphasizing multi-sectoral interventions and offering proposals for policy enhancements.

2. Methods

2.1. Ethics Statements

The study was conducted in Southern Chad and received approval from the national bioethics committee under the reference number 585/PR/PM/MESRI/SEESRI/SG/2016. The study protocol, along with consent documents, was submitted to the committee. Comprehensive information about the study's purpose was provided to the participants. Written informed consent was obtained from all individuals, including the parents or guardians of minors under the age of 18.

2.2. Study Areas

The research focused on two areas in Southern Chad, Kouh-Est and Grand-Sido (**Figure 1**), both part of the Sudano-Guinean savannah geo-ecological zone, characterized by an annual rainfall of 1000 mm to 1300 mm [15]. The rainy season runs from May to October, with the dry season extending from November to April.

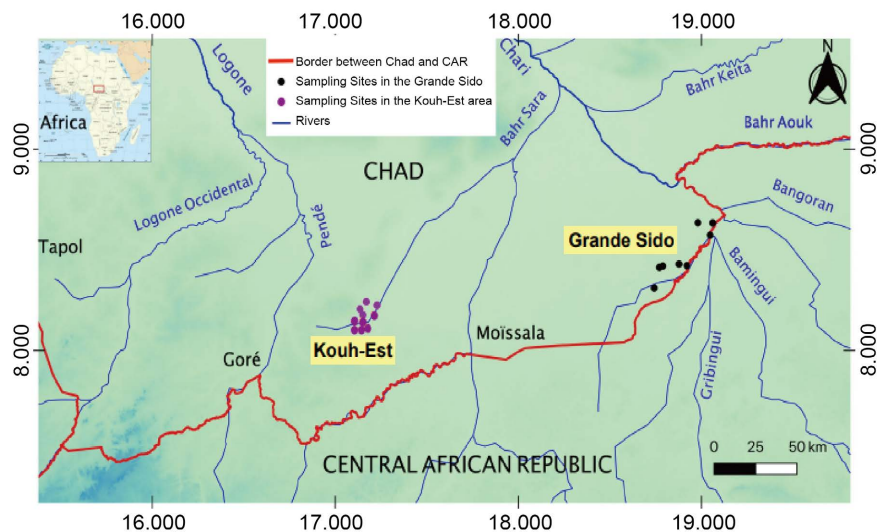


Figure 1. Map showing sampling sites in the Kouh-Est and Grand-Sido in Southern Chad (sources: Map adapted from Ibrahim M.A.M. *et al.*, 2021, data generated from SRTM (Shuttle Radar Topography) topo 30 data, easily accessible and free to download from the site: <https://earthexplorer.usgs.gov/>).

The Kouh-Est area, also known as the Mandoul sleeping sickness focus, is located in the Logone-Oriental province at N8°12.375' E17°08.063'. This historic sleeping sickness focus, demarcated in 2003, spans approximately 15 km by 20 km and houses around 20,000 inhabitants [16]. With ongoing population growth, recent surveillance estimates suggest 38,674 people now living in 117 villages in this

region [17] [18]. The Mandoul riverbanks, shaded by riparian and gallery forests, provide a cool environment conducive to tsetse flies, which thrive in this area as well as snails and other parasite vectors.

Grand-Sido, located on the border with the Central African Republic (CAR), includes the Maro sleeping sickness focus (N8°24.807'E 18°46.139') in the Moyen-Chari province. This region is crossed by multiple rivers, including the Chari and its tributary Grand-Sido, which delimit the CAR border. A 2016 geographic survey by the “Programme National de Lutte contre la Trypanosomiase Humaine Africaine” (PNLTHA) and “Institut de Recherche en Elevage pour le Développement” (IRED) indicated a population of 14,532 across 45 settlements [19], with additional seasonal nomadic pastoralists [13].

The selection of the two areas is based on an ongoing vector (tsetse) control operation, with the annual deployment of Tiny Targets that began in 2014 in Kouh-Est, whereas no similar operations were implemented during the surveys in Grand-Sido. The study adopts the WHO Conceptual Framework of SDOH, comparing an area with an ongoing vector control program (Kouh-Est) to one without (Grand-Sido).

2.3. Inclusion and Exclusion Criteria

Participants were eligible for inclusion if they were aged between 5 and 90 years and resided in the Kouh-East or Grand-Sido. Children under 5 and elderly individuals above 90 years were excluded from the study due to ethical, practical, and safety considerations related to invasive procedures such as blood sampling, which were conducted as part of the survey. Additionally, individuals who declined to participate or were not residents of the specified regions—Kouh-Est and Grand-Sido—were also excluded.

2.4. Study Design and Sampling Procedures

The study was a descriptive, quantitative, population-based, cross-sectional survey, using a face-to-face questionnaire to collect data.

Surveys were conducted in February 2017. In both areas, eight villages were randomly selected, including nomadic, semi-nomadic, and sedentary communities. The survey teams introduced themselves to village heads, explained the study in local languages, and obtained household lists. Households were numbered, and 6 to 16 were randomly selected in each village, with all members from each household invited to participate. The number of participants varied depending on village size and participation. Participants completed questionnaires with the assistance of local interpreters.

Sample sizes were calculated using open-source software, OpenEpi [20] and Raosoft [21]. Based on the populations of Kouh-Est (38,674 in 114 settlements) [18] and Grande-Sido (14,532 in 45 settlements) [19], the required sample sizes for the study were 381 and 375 respectively, with a 5% margin of error and a 95% confidence interval.

2.5. Questionnaires

The questionnaires were adapted from the Chadian Demographic and Health Survey [10], the Tanzania Demographic and Health Survey [22], and Food and Nutrition Technical Assistance [23]. Three forms (Annex 1, 2 and 3) were used. Household questionnaire (1) concerns primarily household heads or their designated caretakers. On the individual questionnaire (2) data on age, gender, marital status, education level, and occupation/income were collected. Health status questionnaire (3) documented participants' knowledge on VBPDs and their prevention methods as well as water supply and the condition of water storage and treatment.

Local facilitators, fluent in local languages and specifically trained for this study, carried out the translation of the questionnaire. This approach effectively bridged language barriers and fostered trust, encouraging more accurate and reliable responses. Additionally, occasional follow-up interviews were conducted to assess the consistency and reliability of self-reported data.

2.6. Statistical Analysis

The general characteristics of the study population were described using standard descriptive statistics including means, standard deviations, and frequencies with the 95% Confidence Interval. The chi-square (χ^2) test was applied to analyse categorical variables and assess differences in literacy and knowledge of VBPDs between groups. Statistical significance was set at $p < 0.05$. SPSS v 22.0 (IBM, USA) was used for the statistic evaluation, GraphPad Prism 7.0 for constructing the graphs, and Microsoft Excel for managing raw data.

3. Results

3.1. Villages Included in the Survey

Eight villages/settlements were visited in the Kouh-Est, while nine in the Grand-Sido, including one military camp having a unit close to one of the visited villages (**Supplementary Table 1**). The lowest number of participants in a village was recorded in the military camp ($n = 19$) and the highest in a nomadic settlement ($n = 73$).

3.2. General Characteristics of the Studied Population

202 households were randomly selected (**Table 1**) in 17 villages overall (**Supplementary Table 1**). Males were predominantly represented as heads of households, either in monogamous (55.0%; 95% CI: 48.5 - 61.9%) or polygamous households (20.8%; 95% CI: 15.3% - 26.7%). The few females recorded as heads of households (9.9%; 95% CI: 5.9% - 13.9%) were mostly widows (35.0%; 95% CI: 15.0% - 55.0%; $n = 7$), divorced (35.0%; 95% CI: 15.0% - 55.0%; $n = 7$), or single (30.0%; 95% CI: 10.0% - 50.0%; $n = 6$). Regarding participants' gender, males and females were almost equally represented, with 50.3% (95% CI: 47.1% - 53.6%) and 49.7% (95% CI: 46.4% - 52.9%), respectively.

Table 1. Overview of data collection and general characteristics of participants.

	Total n (%)	Kouh-Est n (%)	Grande-Sido n (%)	P-value (χ^2)
Number of households	202 (100.0)	83 (41.1)	119 (58.9)	
Average number of household members	4.75	5.0 (max = 18; min = 1)	4.0 (max = 19; min = 1)	
Gender of household head (n = 202)				
Male	182 (90.1)	74 (89.2)	108 (90.8)	0.7080
Female	20 (9.9)	9 (10.8)	11 (9.2)	
Characteristic (n = 890)				
Sedentary	708 (79.55)	379 (92.6)	329 (68.4)	<0.0001
Nomadic	157 (17.64)	30 (7.3)	127 (26.4)	
Military camp	25 (2.80)	-	25 (5.2)	
Matrimonial status (n = 202)				
Single	19 (9.4)	8 (9.6)	11 (9.2)	0.2058
Monogamous	111 (55.0)	38 (45.8)	73 (61.3)	
Polygamous	42 (20.8)	22 (26.5)	20 (16.8)	
Divorced	14 (6.9)	6 (7.2)	8 (6.7)	
Widow	16 (7.9)	9 (10.8)	7 (5.9)	
Source of income (n = 490; >18 yrs)				
None	23 (2.6)	10 (2.4)	13 (2.7)	<0.0001
One source	202 (22.7)	52 (12.7)	150 (31.3)	
More than one source	265 (29.8)	152 (35.5)	113 (23.6)	
Occupation sector (n = 516; >18 yrs)				
None	23 (4.46)	10 (2.4)	13 (2.7)	<0.0001
¹ Primary	434 (84.10%)	197 (48.2)	237 (49.5)	
² Secondary	29 (5.62)	-	29 (3.5)	
³ Tertiary	30 (5.81)	7 (1.7)	23 (4.8)	
Consent form (n = 890)	807 (90.7)	380 (92.9)	427 (88.8)	
Questionnaire (n = 890)	704 (79.1)	307 (75.1)	397 (82.5)	

¹Primary sector includes agriculture, livestock farming and fishing. ²Secondary sector includes military, policemen, civil servant workers, industry workers, and construction's workers. ³Tertiary sector includes services and trade, local drinks producers and transformers. *significant difference; **very significant; ***highly significant.

Sedentary populations were more highly represented than nomadic ones (**Table 1**). The nomadic populations were primarily pastoralists, entering these areas in search of grass and crop residues for their livestock, sometimes staying for more than six months. In addition to these two population groups, a military camp in the Grand-Sido area was also included in the survey.

Regarding socio-professional activities, only adults over the age of 18 (n = 516) responded to this section. The primary sector, including agriculture, livestock,

and fishing, accounted for 84.1% (95% CI: 80.3 - 91.1%) of the participants' activities.

The number of participants who responded to each section of the questionnaire varied. Some participated in the entire survey, while others decided to skip certain sections for their own reasons. Of the 890 individuals registered for the study, 807 (90.7) met the inclusion criteria.

3.3. Literacy Level of Participants

Of the 820 participants, 671 provided responses to the questionnaire regarding their literacy levels (for individuals above six years old). Literacy levels reflect the highest level of education attained by each participant, meaning those with secondary education were not included in the primary level category. The average rates for the two areas were as follows: 36.7% (95% CI: 33.0% - 40.4%) for non-educated, 47.7% (95% CI: 43.9% - 51.5%) for primary school level, 14.5% (95% CI: 11.9% - 17.3%) for secondary school level, and 0.3% (95% CI: 0 - 1.1%) for tertiary level (**Figure 2**). Most of the villages did not have conventional and established schools, and where schools did exist, they typically only provided primary education.

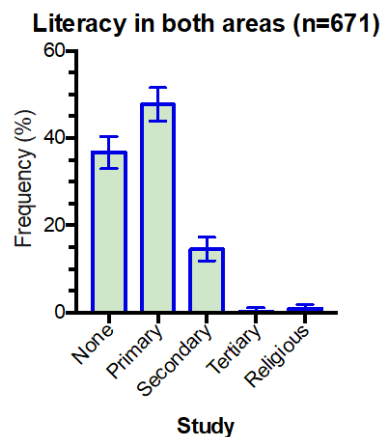


Figure 2. Literacy of participants above six years old. Error bars represent the lower and upper limits of the 95% CI.

There was a statistically significant difference ($p < 0.001$) between the two areas in the proportion of participants who had no formal education (**Figure 3(a)**). Among those who were educated, 48.8% and 46.9% stopped at the primary level, while 21.1% and 9.6% respectively reached the secondary level ($p < 0.001$). Only 0.7% were undergraduate, and 0.8% participants had exclusively religious education.

In terms of nomadic participants, significantly higher had no formal education (71.4%) compared to sedentary participants (28.1%) (**Figure 3(b)**). The difference was statistically significant including both primary and secondary

education levels ($p < 0.0001$).

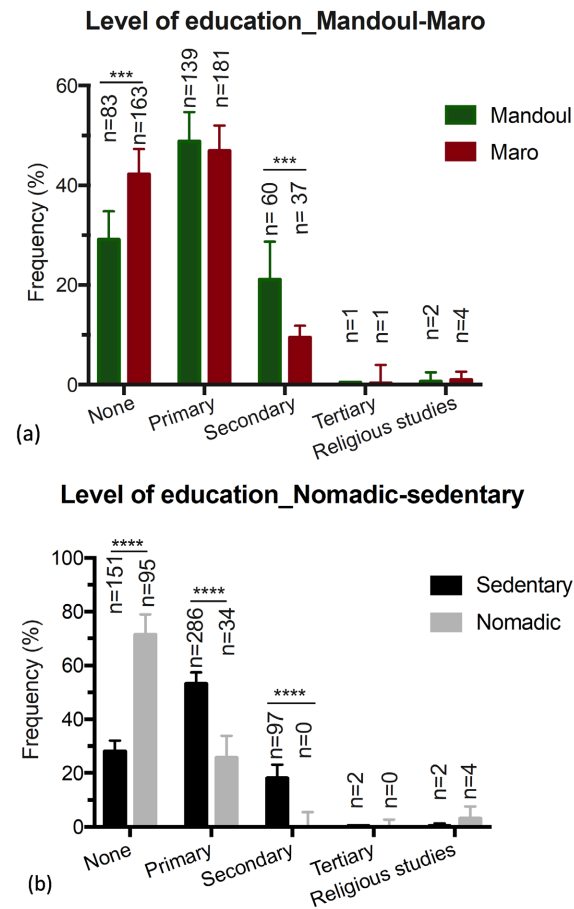


Figure 3. Frequency of participants' literacy. (a) Participants from Kouh-Est (Mandoul) and Grand-Sido (Maro); (b) Nomadic and sedentary participants. Error bars represent the upper limits of the 95% CI. (n) represent the sample size; (***) represent statistically significant difference ($p < 0.001$); (****) represent statistically significant difference ($p < 0.0001$).

3.4. Knowledge of Vector-Borne Parasitic Diseases and Protection Measures

Regarding participants' knowledge of the vectors responsible for common diseases in the areas, both the Kouh-Est (Mandoul) and Grand-Sido (Maro) populations demonstrate a high level of awareness about malaria, with over 65% of respondents in both regions recognizing the disease vector (**Figure 4(a)**). However, the awareness of trypanosomiasis is significantly lower in Grand-Sido compared to Kouh-Est. Kouh-Est shows significantly higher awareness of trypanosomiasis (69.4%) compared to Grand-Sido (52.9%) ($p < 0.001$). Both regions exhibit very low awareness of river blindness, with less than 1% of respondents in each region aware of the disease vector.

No statistically significant difference in knowledge about mosquito vectors was observed between sedentary and nomadic participants (**Figure 4(b)**). However, a

difference emerges when considering knowledge of tsetse fly vectors.

In light of these findings, an exploration of the protective measures used against insect vector bites was evaluated. For protection against mosquitoes, 60% of participants reported using mosquito nets (Figure 4(c) and Figure 4(d)). In Kouh-Est, 12.8% relied on other protective methods, while 25.2% did so in Grand-Sido. Additionally, 19.4% of respondents in Kouh-Est and 10.1% in Grand-Sido did not use any protective measures, with this difference being statistically significant ($p < 0.001$).

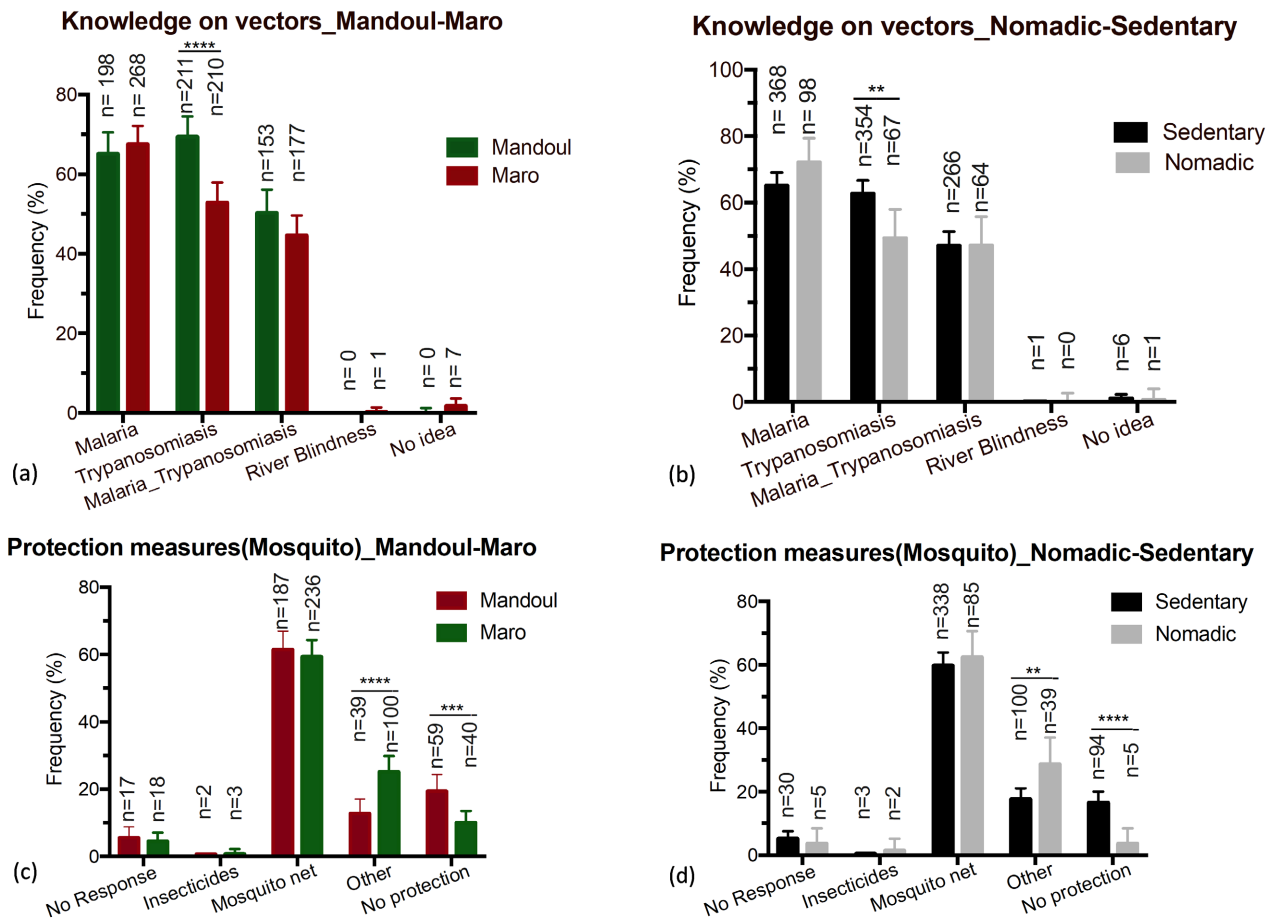


Figure 4. Knowledge of vector parasitic diseases and protection measures. (a) and (c) Participants from Kouh-Est (Mandoul) and Grand-Sido (Maro); (b) and (d) Nomadic and sedentary participants. Error bars represent the upper limit of the 95% CI.

4. Discussion

The findings of this study provide valuable insights into the socio-demographic characteristics and knowledge of VBPDs among populations from Kouh-Est and Grand-Sido areas and sedentary and nomadic of southern Chad. They highlight the impacts of SDOH on VBPDs including malaria, onchocerciasis and trypanosomiasis. These insights could also be extended to other regions with similar population settings, as living conditions in rural Chad—spanning both sedentary and nomadic communities as well as socio-professional activities such as agriculture

and livestock farming—tend to be relatively consistent across these groups.

The assessment of SDOH indices is a tool to help the policymakers and the surveyed communities to improve their well-being.

4.1. Household Structure

In the studied population, most households were headed by men, both in monogamous and polygamous settings, while female-headed households were only 9.9% and mainly composed of widows or divorced women. This gender imbalance in household leadership is cultural in Chad and other sub-Saharan African countries, where patriarchal systems prevail, and men are typically seen as the heads of households [10] [24]. Similarly, in rural Mozambique, women tend to lead households primarily due to widowhood, divorce, or abandonment [25]. The low representation of female-headed households reflects regional socio-cultural norms that prioritize male leadership within family structures.

4.2. Literacy and Education Levels

As an outcome emerging from the data, the level of literacy of the population in the two surveyed areas is generally low, with 36.7% of participants having no formal education and only 14.5% reaching secondary education. Taken alone, the participants from the Grand-Sido area are less educated ($p < 0.001$) than those of the Kouh-Est, as well as nomadic than sedentary ($p < 0.0001$) (**Figure 3(a)**). Low access to school, due to the absence or remoteness of these structures, influences this situation. Most of the villages did not have established schools, and where schools did exist, they typically only provided primary education. This is one of the reasons for the low proportion of participants with secondary education. Factors such as geographic isolation, lack of infrastructure, and the economic necessity for children to work in pastoral or agricultural settings contribute to the lower education rates among rural populations [26]. Our findings also reflect a significant difference in literacy levels between sedentary and nomadic populations. The educational disparity between these groups often results from nomads' mobility, making it difficult for their children to attend formal schools [27] [28].

4.3. Vector Born Parasitic Diseases and Protection Measures

The study revealed that while most participants were aware of mosquitoes as vectors for malaria and tsetse flies as vectors for trypanosomiasis, fewer knew about the black fly's role in transmitting river blindness. The disease might be less prevalent in the regions, leading to reduced public awareness. However, malaria remains the most recognized VBPDs, as evidenced in this study and across sub-Saharan Africa, largely due to extensive public health campaigns [29] and mosquito-net distribution. In rural areas where onchocerciasis is endemic community knowledge is often limited unless there are active disease control programs [30]. This underscores the need for more comprehensive education, sensitisation and outreach regarding less prominent VBPDs in both sedentary and nomadic

populations. In the Mandoul sleeping sickness focus, regular screening campaigns and vector control operations conducted by the PNLTHA and IRED [17] [18], [31] have contributed to greater awareness of the tsetse fly vector, as revealed in this study (Figure 4(a)). These efforts, along with the population's own experiences with the diseases, have enhanced understanding of the impact of vectors in the region. Similar campaigns are needed to raise awareness of other less frequent but still present vectors.

In parallel, we evaluated the protection measures taken against malaria, the common VBPD that has an easy solution by being protected against mosquito's bites. The study observed that 60% of participants reported using mosquito nets, which is consistent with a study conducted in 8 health districts across Chad, where 50.4% of individuals reported sleeping under insecticide-treated mosquito nets [32]. However, some proportions of the surveyed participants did not take any protection measures, which could be due to the health education and sensitisation issues. More sensitisation and improvement of health education is required.

The implementation and sustainability of vector control measures—such as insecticide-treated nets, community spraying, and Tiny Targets for tsetse flies—often depend on robust political will, sustained funding, and effective governance structures. These factors must be continuously encouraged and strengthened, with active involvement from both men and women of local community. However, women, often primary caregivers, may face limited access to health education or healthcare services, which can hinder their ability to prevent and manage VBPDs. By involving women in community engagement, VBPDs could be more effectively addressed through improved dissemination of health education, increased adoption of preventive measures, and enhanced participation in local health initiatives.

4.4. Socio-Professional Activities

The primary sector, encompassing agriculture, livestock, and fishing, represents 84.1% (95% CI: 80.3 - 91.1%) of the populations' activities in these rural areas. This finding aligns with previous surveys in the country [10] [15], which reported that over 80% of rural inhabitants engage in agriculture and/or livestock farming. Additionally, more than 93 million cattle, sheep, goats, camels, and equines have been recorded across the country [33]. In trypanosomiasis-endemic zones, agriculture is widely practiced, and pastoralists frequently cross the border with the Central African Republic (CAR), seeking grass and crop residues for their livestock. These transhumance activities can last in the areas for over six months. The movement of livestock may play a significant role in the transmission of zoonotic diseases.

4.5. Health System and Infrastructure

The health systems in both study areas are characterized by significant challenges, particularly in terms of accessibility and quality of care. Geographical disparities

pose a major barrier. Health facilities are often concentrated in urban centers, leaving rural populations to travel long distances—up to 50 km—to access care, as seen in these two areas. This is especially problematic for emergency situations, maternal health, and chronic disease management. Studies in Sub-Saharan Africa have highlighted similar issues with rural communities facing longer travel times and delayed treatment [34], leading to poorer health outcomes. Limited resources further exacerbate these challenges. Health facilities frequently lack essential medical supplies, diagnostic tools, and infrastructure, hindering their ability to provide adequate care. Additionally, the shortage of trained healthcare professionals limits the scope and quality of services available [35]. Such conditions are common in low-resource settings, contributing to suboptimal care and a lack of trust in the health system.

These combined factors—distance, inadequate resources, and personnel shortages—are compounded by poor road infrastructure, limited transportation options, and economic constraints. This results in worsened health outcomes for rural populations, including higher rates of preventable morbidity and mortality for VBPDs. Addressing these systemic problems is crucial for improving health equity and outcomes in these regions. This aligns with the World Health Organization’s emphasis on strengthening health infrastructure and human resources in rural areas to achieve equitable health outcomes [36].

5. Conclusion and Perspectives

This study reveals that the surveyed populations exhibited varying responses to SDOH, which strongly influenced their susceptibility to infectious diseases. Low education levels and limited awareness hindered the adoption of preventive measures, particularly for VBPDs, as seen in the failure to protect against mosquito bites. The findings highlight the significant impact of socio-economic and lifestyle factors on health outcomes in sedentary and nomadic populations, with disparities in household structure and literacy levels emphasizing the urgent need for targeted public health interventions. Addressing educational inequalities remains an urgent priority as improving literacy and disease awareness can drive behavioural changes necessary for VBPD prevention. Strengthening health infrastructure and education programs, with a particular focus on disease prevention, will be critical to improving health equity and outcomes in these populations and in similar settings more broadly.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Supplementary Table 1. Overview of visited villages and enrolled participants.

Area	Village	Age group (year)			Total n (%)
		5 - 14 n (%)	15 - 59 n (%)	>60 n (%)	
Kouh-Est	Bembaïtada	13 (22.8)	38 (66.7)	6 (10.5)	57 (100)
	Konael	19 (32.8)	37 (63.8)	2 (3.4)	58 (100)
	Kobiteye	10 (22.2)	33 (73.3)	2 (4.4)	45 (100)
	Dedaye I	12 (29.3)	27 (65.9)	2 (4.9)	41 (100)
	Ferrick Sandana Lelou	7 (25.0)	19 (67.9)	2 (7.1)	28 (100)
	Kousserie	8 (19.0)	30 (71.4)	4 (9.5)	42 (100)
	Palkoyo	8 (18.2)	30 (71.4)	0 (0.0)	44 (100)
	Berayan	9 (18.4)	39 (79.6)	1 (2.0)	49 (100)
Total Kouh-Est		86 (23.6)	259 (71.2)	19 (5.2)	364 (100)
Grand-Sido	Ngakorio	26 (35.6)	45 (61.6)	2 (2.7)	73 (100)
	Ferrick Hanno	20 (38.5)	30 (57.7)	2 (3.8)	52 (100)
	Kobdogué	16 (28.1)	39 (68.4)	2 (3.5)	57 (100)
	Ngon-Molo	11 (25.6)	31 (72.1)	1 (2.3)	43 (100)
	Beguiyon	12 (33.3)	24 (66.7)	0 (0.0)	36 (100)
	Baguirgué: Guir-ba	7 (15.9)	32 (72.7)	5 (11.4)	44 (100)
	Guirkyon/Military camp	0 (0.0)	19 (100)	0 (0.0)	19 (100)
	Baguirgue/Military cam	1 (14.3)	6 (85.7)	0 (0.0)	7 (100)
	Aldjazira	14 (19.2)	56 (76.7)	3 (4.1)	73 (100)
Guirkyon	11 (21.2)	36 (69.2)	5 (9.6)	52 (100)	
Total Grand-Sido		118 (25.9)	318 (69.7)	20 (4.4)	456 (100)
Total		204 (24.9)	577 (70.4)	39 (4.8)	(100)